EMBRYOLOGY

Team 435

NERVOUS SYSTEM

NEUROPSYCHIATRY BLOCK

DEVELOPMENT OF CEREBRUM AND CEREBELLUM

Objectives

- ✓ Describe the formation of the neural tube.
- ✓ List the 3 brain vesicles and their derivatives.
- ✓ Describe the brain flexures.
- ✓ Describe briefly the development of the cerebrum.
- ✓ Describe briefly the development of the cerebellum.
- ✓ Enumerate some congenital anomalies in development of CNS.

References

- ✓ 435 embryology (males & females) slides.
- ✓ Pathoma Book (IN DEVELOPMENTAL ANOMALIES PART).

Color index

- ✓ **IMPORTANT**
- ✓ **Day, Week, Month**
- ✓ **Doctor notes and extra information.**

Team members

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Revised by

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يعتبر العمل مصدر للمذاكرة ولمن أراد المراجعة يوجد ملخص بآخر الشرائح.

✓ INTRODUCTION (revision of the first lecture)

By the beginning of the **3rd week** of development, three germ cell layers become established, Ectoderm, Mesoderm and Endoderm.

EARLY DEVELOPMENT ,During the **middle** of the **3rd week**:

1. The dorsal midline ectoderm undergoes thickening to form the neural plate (neuroectoderm).
2. The margins of the plate become elevated, forming neural folds. So a longitudinal, midline depression, called the neural groove is formed.
3. The 2 neural folds then fuse together, thus sealing the neural groove and creating the neural tube.

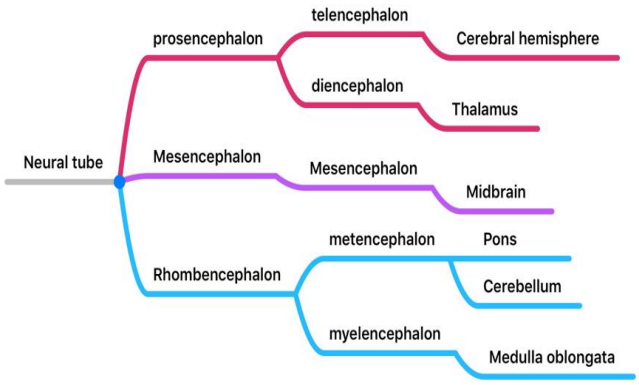
✓ Neural Tube Development

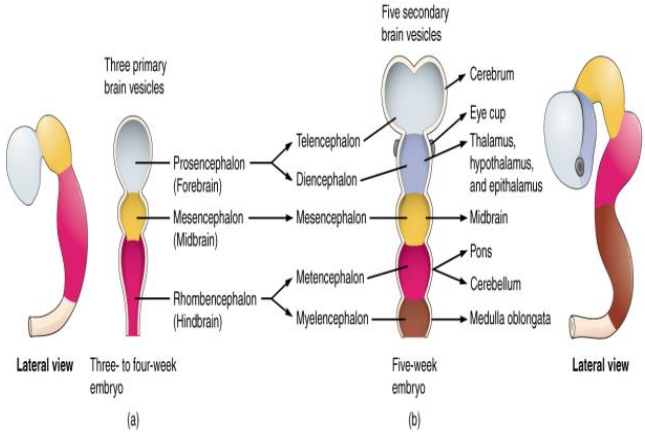
- **Three (** primary**)** - vesicles stage (**End of 4th Week**)

In the **middle** of the **4th week**.	By the **end** of the **4th week,**
The Formation of the neural tube is **completed**	Its upper end dilates & shows 3 vesicles: Prosencephalon (forebrain). Mesencephalon (midbrain). Rhombencephalon (hindbrain).

- By the **5th week** further differentiation distinguishes **five** 2ry (secondary) brain vesicles from the primary vesicles:

The prosencephalon	The Rhombencephalon
divides into the two **telencephalon** and one **diencephalon.**	divides into **metencephalon** and **myelencephalon**.



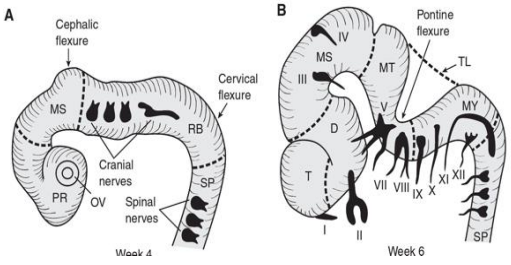


- Brain Flexures

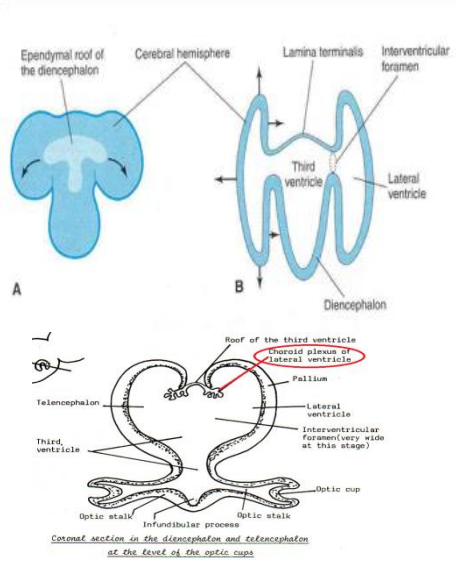
By the **4th week** , The neural tube grows rapidly and bends ventrally, producing **two** flexures:

1. Midbrain flexure: (cephalic) between the **prosencephalon** & the **mesencephalon** (midbrain)
2. Cervical flexure: between the **Rhombencephalon** (hind brain)& the **spinal cord**.

Later Pontine flexure appears in the **hindbrain**, in the **opposite direction,** resulting in thinning of the roof of the hindbrain.



✓ Development of the cerebrum (cerebral hemisphere)



The cerebrum develops from the **Telencephalon.**

- Differentiation of Forebrain Vesicle, The (prosencephalon) or the forebrain vesicle differentiates into a:
  1. **Median** part(**diencephalon**).
  2. **Two lateral** cerebral vesicles or (**telencephalic** vesicles.)

The **lumen** gives the **2 lateral ventricles** and the **3rd ventricle** Both cavities communicating with each other through a wide interventricular foramen.

The cerebral hemispheres expand in all directions .Its **medial** wall becomes **thin**, **flat** and it is the site of choroid plexus[1] of the **lateral ventricle.**

- The 3 layers formed the **telencephalon wall :**

Ependymal	Mantel	Marginal
lining the cavity of the **lateral ventricle**.	**nerve cells** forming the **grey matter**.	**nerve fibers** forming the **white matter**.

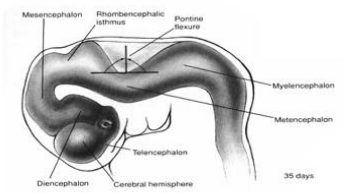
- As development proceeds the following **changes** occur:

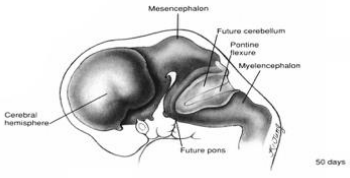
Most of the **nerve cells** in **mantel** layer **migrate** to the **marginal** layer forming the cerebral cortex. **Some** cells **do not migrate** and **remains** to form the **basal ganglia.**

لازم نشغل خيالنا هنا ونعرف ليه صار هذا الانتقال في الخلايا في المخ ولم يحدث في الحبل الشوكي ؟ لأن القشرة الخارجية للدماغ تتكون من grey matter و أما الداخل فهو متكون من white matter بعكس الحبل الشوكي ، ولكن الملاحظ هنا بأنه ليست جميع الخلايا ستتنتقل وانما سيبقى جزء قليل منها لماذا ؟ لان بيتكون لنا basal ganglia اللي هي عبارة عن كتلة من grey matter داخل white matter .

- Development of the cerebrum

دكتورة سناء ركزت على بعض الأشياء هنا (الكلام البارز هنا سواء بالألوان او الخط) قالت الباقي عشان تفهمون أكثر.





- The cerebral hemispheres **first** appear on the **day 32**(5th week)as a pair of **bubble-like** outgrowths of the Telencephalon.
- By **16 weeks**, the rapidly growing hemispheres are **oval** and have expanded back to cover the diencephalon.
- By the **end of the 3rd month** the **surfaces** of the cerebral hemispheres are **smooth**.
- By the **4th month** the grey matter grows faster than the white matter, so, the cortex becomes **folded** into **gyri** separated by **sulci**. The gyri and sulci effectively increase the surface area of the brain and The detailed pattern of gyri & sulci varies somewhat from individual to individual.

[1] CSF is constantly produced by the choroid plexuses inside the ventricle.

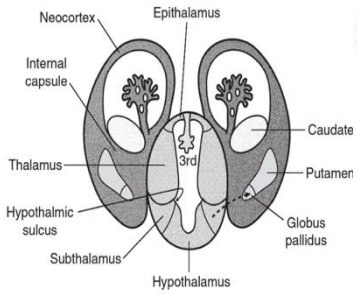
- ## Corpus striatum

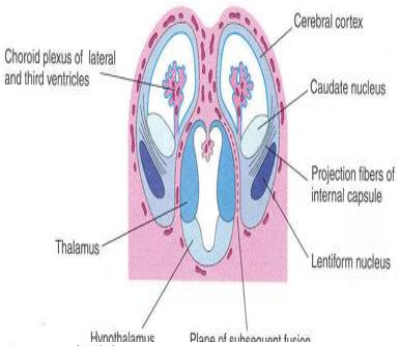
It appears in **6th week** in the **floor** of each **cerebral hemisphere.** As the cerebral cortex differentiates and the fibers passing to and from it, pass through the corpus striatum. The corpus striatum now **divides** into :

1. caudate nucleus.
2. lentiform nucleus.

This fiber pathway forms the **internal capsule.**

Further expansion of cerebral hemisphere gives **C-shape** appearance to the hemisphere itself as well as its cavity (lateral ventricle). Also the caudate nucleus **elongates** and assumes the shape of the lateral ventricle and remains related to it.

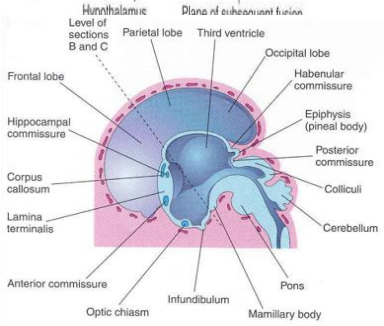




- ## Development of the Cerebral Commissures

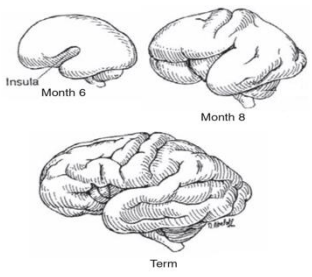
As the cerebral cortex develops, **group of fibers, (commissures)**, connect the corresponding regions of the cortex. These are:

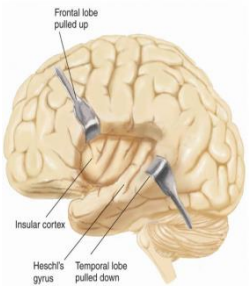
- Lamina terminalis.
- Optic chiasma.
- Anterior commissure.
- Posterior commissure.
- Hippocampal commissure.
- Habenular commissure.
- **Corpus callosum.**(is a major commissural fibres that connect the two cerebral hemispheres).



- ## Development of Insula

The cortex covering the surface of the corpus striatum grows relatively **slower than the other cortices**, so it is **overgrown** by the rest of the hemisphere and lies in the depth of the lateral sulcus. This is called the **insula**. So, the **insular lobe** is a portion of cerebral cortex that has invaginated to lie **deep within the lateral sulcus.**

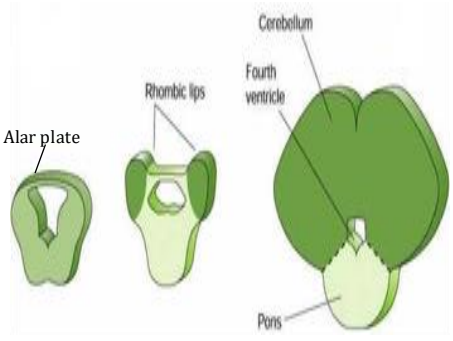




بالمختصر القشرة الخارجية تنمو أسرع من القشرة اللي تغطي سطح الكوربس ستريتم فنتخيل قشرة الكوربس ستريتم هي الجزء المسكين اللي يخلونه بالداخل لأنه بطيء ما ينمو معهم ، عشان كذا هو بيصير في العمق لأن القشرة الخارجية نمت بسرعة وصارت تضغط عليه وهو بدوره يضغط الكوربس ستريتم و ونقدر نشوف الانسيولا اللي هي القشرة البطينة لما نوخر القشرة الخارجية " نفس الصورة "الان زي ما قلنا هي بتكون في العمق.

✓ Development of the cerebellum

It develops from the dorsal part of the **Metencephalon.** The metencephalon develops into the **pons** and overlying **cerebellum**.

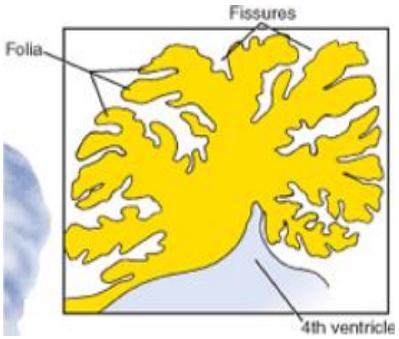


- **Pontine flexure** results in:
  1. Moving the **alar plates** laterally then **pending** medially.
  2. Stretching and thinning of the **roof plate.**
  3. Widening of the cavity to form the **4th ventricle.**

- **Metencephalon**

  Changes in Alar plates :

  a. The dorsal parts **thicken** to form **Rhombic lips,** that will give rise to the **cerebellum**.
  b. **Some** neuroblasts **migrate** from the **mantle layer** to the **marginal layer** and form the cerebellar cortex. Others **remains** in the **mantel layer** and give rise to the **cerebellar nuclei.** نفس الكلام في المخ نطبقه على المخيخ
  c. The cerebellar peduncles develop **later** as the **axons** of the neurones of the **cerebellar nuclei** grow out to reach the brain stem.



As the cerebellar hemispheres develops they undergo a complicated process of **transverse folding** to form closely packed, **leaf-like transverse gyri called folia.**

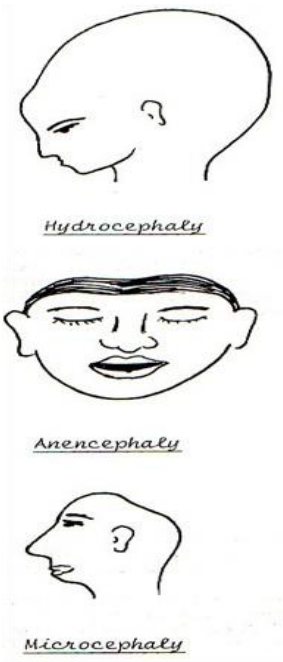
These processes of fissure formation and foliation continue throughout embryonic, fetal, and postnatal life, and they vastly increase the surface area of the cerebellar cortex.

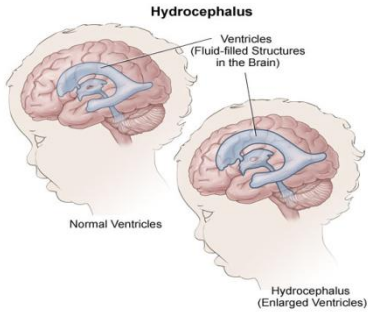
Embryonic period : 8 weeks from the moment of fertilization

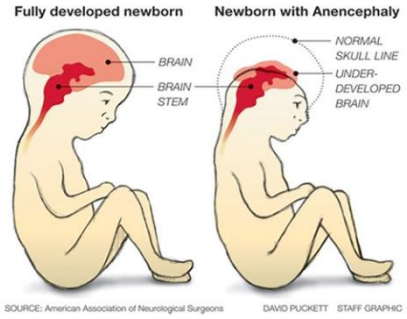
Fetal period: from the last day of the eighth week and continues until birth.

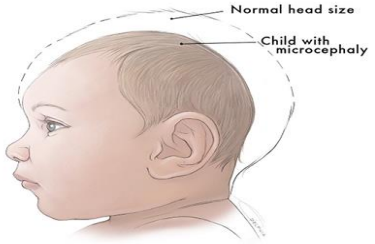
✓ Congenital Anomalies of The Brain

1-	Mental retardation.	
2-	Seizures	changes in electrical activity.
3-	Cerebral palsy.	
4-	Cranium bifidum with or without meningocele &meningoencephalocele.	
5-	**Microcephaly** (صغر الرأس ـ الصعل)	Abnormal **smallness of the head,** a congenital condition associated with incomplete brain development
6-	Agenesis of corpus callosum.	
7-	**Hydrocephalus**. (الاستسقاء الدماغي) Hydrocephalus is a condition in which there is an abnormal accumulation of cerebrospinal fluid (CSF) within the brain:	
7a.Congenital: **Arnold-Chiari malformation** (herniated part of cerebellum through the foramen magnum leading to CSF obstruction ,so hydrocephalus results).		**7b.Acquired**: in **aqueductal stenosis** and in **brain tumours.**
8-	**Anencephaly** (انعدام الدماغ)	in anencephaly, the **brain and skull are minute** and the infant does not usually survive. It is due to **failure of closure of the cranial neuropore** of the neural tube. The frequency of this case 1:1000.







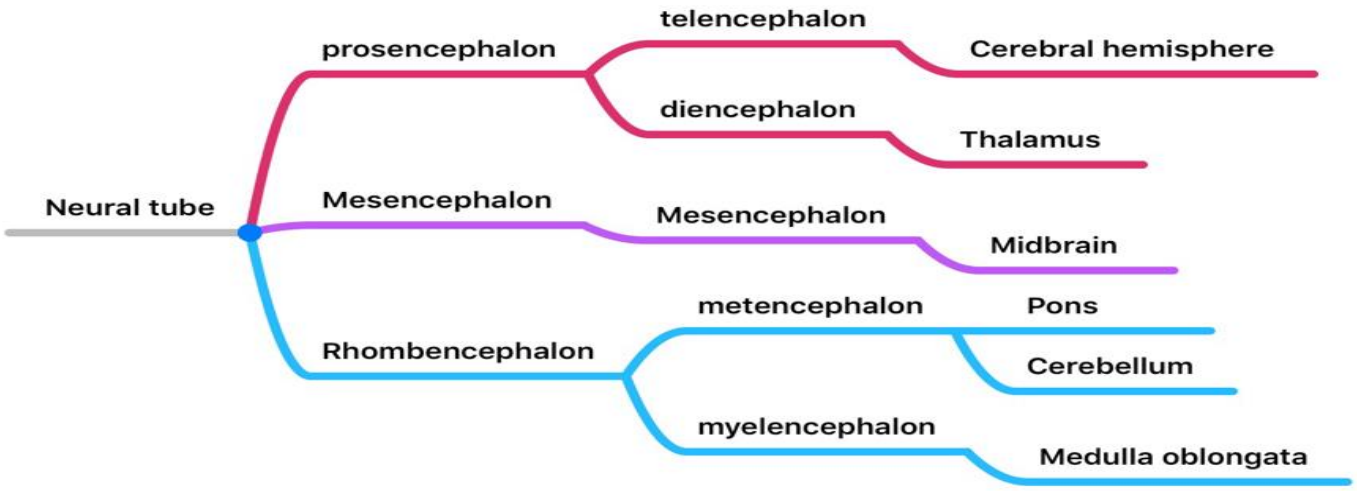


Summary

Structure	Origin
Neural plate	the dorsal midlineectoderm
Cerebrum	Telencephalon
Cerebellum	Metencephalon (Rhombic lips)
pons	metencephalon

3rd week	three germ cell layers appears
4th week	Appearance of brain flexures.
4th week (middle)	complete neural tube.
4th week (end)	the 3 vesicles appearance.
5th week	• (Day32) appearance of cerebral bubble. • The 5 secondary brain vesicles appearance
6th week	appearance of Corpus striatum.
Week 16	cerebral growing is oval.
3rd month (end)	Surface of cerebral hemisphere is **smooth**
4th month	gray matter of cerebral grow faster than white (cortex becomes folded into **gyri** separated by **sulci**)

Microcepha.	Abnormal **smallness of the head,** a congenital condition associated with incomplete brain development
Hydrocephalus	**Congenital** :**Arnold-Chiari malformation** herniated part of cerebellum through the foramen magnum leading to CSF obstruction. **Acquired:** in **aqueductal stenosis** and in **brain tumours**
Anencephaly	In anencephaly, the **brain and skull are minute** and the infant does not usually survive.



MCQ's

1- Aqueductal stenosis is an acquired condition that cause

a. Microcephaly
b. Hydrocephalus
c. Seizures
d. Anencephaly

2- In which one of these brain anomalies the brain and skull are minute and the infant does not usually survive

a. Anencephaly
b. Hydrocephalus
c. Microcephaly
d. Cerebral palsy

3- Arnold-Chiari malformation cause

a. Anencephaly
b. Microcephaly
c. Hydrocephalus
d. Cerebral palsy

4- The distinguish of five secondary brain vesicles from the primary vesicles is in

a. 3rd month
b. 4th month
c. 5th week
d. 3rd week

5- Corpus striatum appears in the floor of each cerebral hemisphere in the

a. 3rd month
b. 4th month
c. 3rd week
d. 6th week

6- Surfaces of the cerebral hemispheres are smooth in the

a. End of 3rd month
b. 6th week
c. Beginning of 3rd month
d. 4th month

7- Surfaces of the cerebral hemispheres are convoluted by the

a. 4th month
b. End of 5th week
c. 6th week
d. End of 3rd month

8- Processes of fissure formation and foliation:

a. Stop at 4th month
b. Stop at 3rd month
c. Continue through postnatal life
d. Stop at 5th week

9- The cerebellum give rise from:

a. Telencephalon
b. Rhombic lips
c. Myelencephalon
d. Diencephalon

10- Metencephalon develops into:

a. Pons and cerebellum
b. Cerebral hemisphere
c. Pons
d. Medulla oblongata

11- Cerebellum develops from:

a. Anterior part of metencephalon
b. Dorsal part of metencephalon
c. Superior part of metencephalon
d. Inferior part of metencephalon

12- Insular lobe lies deep in the

a. Anterior sulcus
b. Posterior sulcus
c. Median sulcus
d. Lateral sulcus

13- ..... is a major commissural fibers that connect the two cerebral hemisphere

a. Hippocampal commissure
b. Anterior commissure
c. Corpus callosum
d. Posterior commissure

14- nerve cells forming the grey matter called:

a. Marginal
b. Mantle
c. Ependymal
d. Both A & B

1	2	3	4	5	6	7	8	9	10	11	12	13	14
b	a	c	c	d	a	a	c	b	a	b	d	c	b